CLAIMS

What is claimed is:

1   1.   An apparatus for reducing the parachuting of a probe measuring the

2   topography of a surface comprising:

3   an oscillating probe;

4   a phase detection circuit coupled to the oscillating probe; and

5   a probe drive boosting circuit coupled to the phase detection circuit and the probe,

6   wherein the phase detection circuit detects a reduction of a variation of a phase

7   signal from the probe and the probe drive boosting circuit boosts a signal to

8   the probe based on the phase signal detected by the phase detection circuit to

9   produce a boosted probe drive signal.

1   2.   The apparatus according to claim 1, wherein the phase detection circuit

2   comprises:

3   a precision full wave rectifier; and

4   an envelope detector coupled to the precision full wave rectifier,

5   wherein the precision full wave rectifier rectifies a phase signal of the probe to

6   produce a rectified phase signal and the envelope detector detects the

7   rectified phase signal to produce an envelope detected signal.

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1   3.   The apparatus according to claim 2, wherein the phase detection circuit

2   further comprises:

3   a comparator coupled to the envelope detector; and

4   an event detector and hold off circuit coupled to the comparator,

5   wherein the comparator and the event detector and hold off circuit generate an event

6   signal from the envelope detected signal.

1   4.   The apparatus according to claim 3, wherein the phase detection circuit

2   further comprises a multiplier coupled to the event detector,

3   wherein the multiplier combines the event signal with a probe drive signal to

4   produce the boosted probe drive signal.

1   5.   The apparatus according to claim 3, wherein the phase detection circuit

2   further comprises:

3   a multiplier coupled to the event detector; and

4   a control module, wherein the multiplier combines the event signal with a gain

5   setting in the control module to increase error integration.

1   6.   The apparatus according to claim 4, further comprising an event level setting

2   circuit coupled between the event detector and hold off circuit and the multiplier, wherein

3   the event level setting circuit sets an event level of the event signal.

1　7.　The apparatus according to claim 4, wherein the boosted probe drive signal

2　is boosted 20 to 30 percent of the probe drive signal above the probe drive signal.

1　8.　The apparatus according to claim 3, wherein the event detector and hold off

2　circuit delays the generation of the event signal for a predetermined time.

1　9.　A method for reducing the parachuting of a probe obtaining accurate

2　information representative of a surface of a sample comprising:

3　scanning the surface of the sample with an oscillating probe;

4　detecting a reduction of a variation of a phase signal of the probe indicative of free

5　oscillation of the probe; and

6　reducing a distance between the probe and the sample in response to the detection of

7　the reduction of the variation of the phase signal of the probe.

1　10.　The method according to claim 9, wherein the detecting step further

2　comprises:

3　rectifying the phase signal of the probe to produce a rectified phase signal; and

4　envelope detecting the rectified phase signal of the probe to produce an envelope

5　detected phase signal of the probe.

1   11.   The method according to claim 9, wherein the reducing step further

2   comprises boosting a drive signal of the probe to produce a boosted drive signal of the

3   probe.

4   12.   The method according to claim 11, wherein the detecting step further

5   comprises triggering an event signal based on the detected phase signal and the boosting

6   step further comprises boosting the drive signal of the probe by combining the event signal

7   with the drive signal of the probe to produce a boosted drive amplitude signal.

1   13.   The method according to claim 12, wherein the detecting step further

2   comprises delaying the triggering of the event signal for a predetermined time.

1   14.   The method according to claim 11, wherein the boosted drive signal is 20 to

2   30 percent of the drive signal above than the drive signal.

1   15.   The method according to claim 9, further comprising:

2   detecting an error signal of the probe when the oscillating amplitude of the probe is

3   too high; and

4   accumulating the error signal of the probe.

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1   16.   The method according to claim 9, further comprising:

2   detecting an error signal of the probe when the oscillating amplitude of the probe is

3   too small; and

4   accumulating the error signal of the probe.

1   17.   The method according to claim 9, wherein the detecting step detects a

2   reduction of a variation of a phase signal when the phase difference between a sinusoidal

3   drive and a probe response signal is substantially 90 degrees.

1   18.   The method according the claim 9, wherein the reducing step further

2   comprises boosting a drive signal of the probe to increase the accumulation of an error

3   signal of the probe.

1   19.   An apparatus for reducing the parachuting of a probe measuring the

2   topography of a surface comprising:

3   an oscillating probe;

4   parachuting detection circuitry coupled to the oscillating probe

5   parachuting reduction circuitry coupled to the parachuting detection circuitry,

6   wherein the parachuting reduction circuitry reduces the parachuting of the

7   probe in response to the detection of parachuting of the probe.

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1   20.   The apparatus according to claim 19, wherein the parachuting detection

2   circuitry comprises a phase detection circuit and the parachuting reduction circuitry

3   comprises a probe drive boosting circuit.